CONTEMPORARY METALLIC MATERIALS

Md Abdul Maleque
Iskandar Idris Yaacob
Zahurin Halim

IIUM PRESS

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

CONTEMPORARY METALLIC MATERIALS

Edited by:

Md Abdul Maleque

Iskandar Idris Yaacob

Zahurin Halim

IIUM Press

Published by:
IIUM Press
International Islamic University Malaysia

First Edition, 2011

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

ISBN: 978-967-418-164-2

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM
(Malaysian Scholarly Publishing Council)

Printed by :
IIUM PRINTING SDN. BHD.
No. 1, Jalan Industri Batu Caves 1/3
Taman Perindustrian Batu Caves
Batu Caves Centre Point
68100 Batu Caves
Selangor Darul Ehsan

Table of Content

Chapter 003

Microstructure and Mechanical Properties of Neutron Transmutation Doped Silicon under Cf-252 Neutron Bombardment

[1]Agus Geter Edy Sutjipto and [2]Roslan Yahya
[1]Kulliyyah of Engineering – International Islamic University Malaysia
[2]Plant Assessment Technology Group, Industrial Technology Division
Malaysian Nuclear Agency, Bangi, 43000 Kajang, Selangor
✉ : agus@iium.edu.my

Keywords: Neutron transmutation doped (NTD), Silicon

Abstract: Silicon substrates (silicon wafer) have been currently irradiated by californium-252 (Cf-252) isotopic neutron radioactive source. Instead of using neutron source from nuclear reactor, isotopic neutron source has been directly used to irradiate the silicon in order to obtain Neutron Transmutation Doped (NTD) silicon. In conjunction with NTD process, microstructure of irradiated silicon has been examined by using Field Emission Scanning Electron Microscope (FESEM) and the concentration of the impurities (Phosphorous) has been determined by Energy Dispersive Spectrometry (EDS) system. Surface morphology of rough microstructure was observed under FESEM for irradiated silicon and the hardness changes was measured by nanoindentation system. The increase of phosphorous impurities for irradiated silicon has been successfully identified via EDS.

Introduction

It is necessary to dope silicon with impurities in order to make possible current flow through the bulk of the silicon for the power devices. Traditionally, thermodynamics plays an important role since nearly all impurities tend to remain in the melt. In contrast, the role played by the thermodynamics is negligible for Neutron Transmutation Doped (NTD) that incorporated nuclear reactor [2-4]. Certainly, the irradiation-induced Phosphorous atoms are created by means of neutron capture by a ^{30}Si atom and forming the unstable ^{31}Si isotope. This ^{31}Si subsequently transmutes to ^{31}P by β- emission and indirectly create phosphorous-doped silicon.

A high density of defects created by the silicon atom after thermal-neutron captures as well as by the direct collisions of fast neutrons has been reported during the transmutation process by Abbaci et al. [1]. Using NTD method, phosphorus dopant will be uniformly distributed and will be also substituted in the lattice whereby it can act as a donor [2]. A few patents have been developed [2-3]. However most of the patents' methods utilised neutron emission from nuclear reactor as neutron source. In order to develop more economically and low risk irradiation facility for NTD process, isotopic neutron source Cf-252 has been used instead of nuclear reactor.